INSTITUTE FOR DEFENSE ANALYSES

Understanding Acquisition Cycle Time: Focusing the Research Problem

Richard H. Van Atta

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About this Publication

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Executive Summary

The Institute for Defense Analyses (IDA) was asked by the Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L)) to address the question: What are ways of assessing acquisition time and issues of acquisition *cycle time* and *cycle time growth*? In considering this question, IDA placed it in the following context: How much should the Department of Defense (DOD) focus on managing cycle time or schedule per se? Or is cycle time generally driven by—a function of—other decisions that if managed properly would result in *reasonable* cycle times from the standpoint of providing capabilities when needed? What is the basis for determining what is reasonable?

Overall Findings

1. *Acquisition program cycle times are slightly longer now than in past decades.*[1] However, there is little evidence that this is, of itself, a problem, or what problems increasing cycle times either cause or indicate. Nonetheless, DOD program development approaches result, in the aggregate, in too many programs simultaneously chasing too few dollars, such that the chance of all programs being effectively implemented as scheduled is unlikely. There is clear evidence that stretching programs results in increased costs overall and per unit acquired. There is high variability in program development time. This raises the question: Are there management measures for disciplining the weapons development process that can overcome these dynamics?
2. *Low priority and focus given to setting initial schedules is a management issue that the USD(AT&L) might want to address.* These initial schedules become embedded in contracts and affect subsequent acquisition milestones, but the processes that determine these schedules appear to be analytically weak. What can be done to improve schedule development? How does the requirements process address schedules and how are requirement imperatives translated into program schedules? This would include addressing how the requirements process develops and provides inputs into

[1] This statement is based on the *Performance of the Defense Acquisition System, 2013 Annual Report*, which states that "development cycle time on contracts after 1980 took an average of 0.9 years longer than contracts before 1980…" Office of the Secretary of Defense, *Performance of the Defense Acquisition System, 2013 Annual Report* (Washington, DC: DOD, 28 June 2013), 55.

program schedules. The Office of the Secretary of Defense (OSD) might want to take on this issue, but doing so would require addressing underlying factors in the development process.

3. *Long cycle times frequently result from the pursuit of highly ambitious technical capabilities combined with a program management framework lacking appropriate mechanisms for identifying and reducing technical risk*. Are there development management approaches (such as prototyping) that would better identify technical risks and discipline developments to accommodate risk? What is needed to apply such measures effectively?

4. *Developmental shortfalls not addressed early will stretch cycle time.* When initial operational test and evaluation (IOT&E) reveals problems late in the process, development schedules are often stretched. This raises fundamental questions: Are the developmental testing (DT) and early operational testing (OT) inadequate? Are the reporting and decision processes ineffective? Are there actions OSD could take to improve the rigor of DT and early OT, or to better address the schedule impacts from problems identified in OT?

5. *Efforts to dramatically shorten cycle times appear to be episodic and short-lived.* Despite periodic calls for dramatically reduced cycle times (such as a 50 percent reduction), various rapid development processes employed during times of conflict are seen as exceptions and fall into disuse when the conflict ends.

Three Different Management Problems

The assessment identified three different management problems related to acquisition cycle time.

1. *Setting realistic schedules:* The first problem is effectively assessing what a reasonable schedule for a program should be relative to explicit choices of performance capabilities: How much of what is needed by when? How time constrained is the need relative to the level of capabilities needed? Analyses have shown that DOD programs have been overly optimistic in determining how long it will take to achieve the stated capabilities. Moreover, there appears to be limited analytical focus on assessing the time it will take to achieve one level of capabilities relative to another level and trading off the level of performance in favor of earlier delivery. Another factor in setting realistic schedules is identifying and providing for uncertainties in achieving the desired outcomes. Should programs fund parallel risk reduction efforts, such as the development of alternative designs for key components, with the expectation that this will reduce the potential for delays? Producing realistic and well-determined initial schedules appears to be a fundamental problem for defense management.

2. *Reducing schedule growth:* Once a schedule is set, data show that programs often do not adhere to the schedule, do not meet intermediate milestone dates, and usually deliver late. We believe this stems largely from the first problem: overly

optimistic initial schedules cannot be met and thus they will likely "creep" longer. However, even with well-formulated initial schedules, incentives and exigencies tend toward longer times than planned. Thus, a useful focus would be identifying motivations, incentives, and other factors that foster schedule growth and addressing how these can be mitigated.

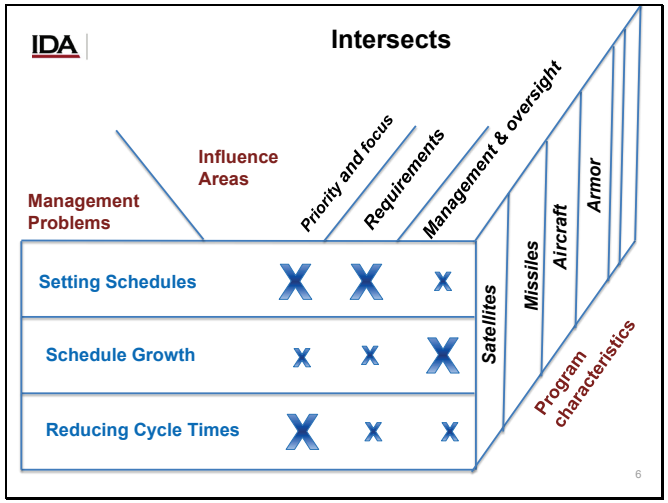
3. *Reducing cycle times:* Data show that DOD major systems development tend to take many years—on the average of seven to ten years. Moreover over recent decades, the cycle time has gotten longer. It is important to note that DOD systems stress several domains, such as performance, operational deployment environment, and length of system use, that are extreme compared to most commercial systems. Achieving shorter schedules for highly complex and technically challenging systems must be accomplished with careful regard to the overall outcome; often trying to do too much too soon has resulted in unsatisfying outcomes and often longer, not shorter, development times.

This leads to the observation that *properly designing both the system and program are essential*. For a projected schedule to be meaningful and useful, the project itself must be well-formed, based on sound engineering, and a schedule derived from the work needed to achieve the intended result. No schedule can make up for a faulty design.

From this overall perspective five focus questions were identified for further research:

1. *Priority and Focus*: How important is cycle time in the decision process and how do the current processes for setting and assessing schedules reflect the management interest?
2. *Requirements Definition:* How are requirements for programs set and how do these impact program schedules? Related to this is the question of what type of information is available and what analyses are done during requirements formulation that impact on setting the initial schedules? When can realistic program schedules be set relative to the degree of program definition?
3. *Management and Oversight*: How are schedules set, assessed, and evaluated relative to overall management of the program?
4. *Program Definition and Characteristics*: How do types of programs—different types of systems or capabilities—affect how long a program takes and how well a program's schedule can be predicted and maintained?
5. *Approaches to Reduce Cycle Time*: What has been tried? What has worked? When is substantially reduced time-to-product appropriate?

The following diagram portrays how these assessment areas relate to the three key management problems stated above.



As this research elaborates, some of these assessment areas seem of greater importance to particular management problems, but this is also something that will be better understood as research proceeds. The large Xs in the slide denote the areas hypothesized to be of greatest relevance for future research focused on that management problem—for example in "setting schedules," "priority" and "requirements" are likely to be of greatest relevance, while "management and oversight" is less of a factor (denoted by a smaller x). Alternatively, for "schedule growth" our hypothesis is that "management and oversight" will be the dominant factor.

"Program characteristics" are depicted as an additional dimension, as the impact of different types of systems or program characteristics on setting schedules and managing them is seen as variable and largely undetermined—that is, certain types of systems may pose much larger or different challenges than other types. However, it is not yet clear from available empirical analyses which programs have which effects. Thus, while program characteristics may be an important factor in reducing cycle times, specifically which types of programs would have such effects is an open empirical question.

Overall, this matrix indicates that more research is needed in the areas identified to lead to useful management interventions for reducing weapon system acquisition cycle time.

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Annotated Final Briefing

Richard Van Atta

April 7, 2014

Research Focus

How much should the Department of Defense (DOD) focus, specifically, on managing program development cycle time (schedule)? Or is cycle time principally driven by—a function of—other decisions that if managed properly would result in "reasonable" cycle times that provide capabilities when needed? What is the basis for determining what is reasonable?

The Institute for Defense Analyses' (IDA) perspective, based on its research and a review of the broader literature, is that *cycle time is largely determined by a set of decisions* in three domains:

1. How well the program is formulated at its inception relative to what is known and taken into consideration about the program risks related to the technologies to be developed and incorporated
2. The clarity, specificity, and stability of the user requirement for the capability
3. The priority of the program relative to adequate initial funding and persistent funding during budget cycles

This analysis draws upon prior IDA research, as well as studies by the RAND Corporation, the Military Services (primarily the U.S. Air Force), the Office of the Secretary of Defense (OSD) and others. IDA also reviewed data analyses that have been conducted for these studies and identified additional data and assessments that may provide greater understanding of program cycle time. The objective of this initial investigation of cycle time issues was to define a *program of future research* that would illuminate the causes of problematic growth in acquisition program cycle times and identify management mechanisms to address those causes.

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Research Focus

- **Research question:** What are ways of assessing acquisition time and issues of acquisition "cycle time" and "cycle time growth" that provide useful/actionable inputs for the Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L))?
- **Approach:** First phase is a "Capstone Perspective"
  - Addresses cycle time issue from a management perspective.
  - What does the data show are prospects for understanding cycle time and managing its effects?
  - Define set of hypotheses and analyses on specific types of causes to help identify management "levers" or approaches.
  - Based on data and a literature review to identify alternative hypotheses demonstrating management implications for further assessment.
- **Deliverable:** A research program defining the analytical tasks to address acquisition cycle time as a management problem

Summary of Cycle Time Issues

Acquisition program cycle times are slightly longer now than in past decades.[1] There is little evidence that this is, of itself, a problem, or what problems increasing cycle times either cause or indicate. There is clear evidence that stretching programs results in increased costs overall and per unit acquired. There is high variability in program development times. Are there management measures for disciplining the weapons development process that can overcome these dynamics?

Low priority and focus given to setting initial schedules is a management issue that the USD(AT&L) might want to address. These initial schedules become embedded in contracts and affect subsequent acquisition milestones, but the processes that determine these schedules appear to be analytically weak. What can be done to improve schedule development? How does the requirements process address schedules and how are requirement imperatives translated into program schedules?

Long cycle times frequently result from the pursuit of highly ambitious technical capabilities combined with a program management framework lacking appropriate mechanisms for identifying and reducing technical risk. Are there development management approaches (such as prototyping) that would better identify technical risks and discipline developments to accommodate risk? What is needed to apply such measures effectively?

Developmental shortfalls not addressed early will stretch cycle time. When initial operational test and evaluation (IOT&E) reveals problems late in the process, development schedules are often stretched. Are the developmental testing (DT) and early operational testing (OT) adequate? Are the reporting and decision processes effective? Are there actions OSD could take to improve the rigor of DT and early OT, or to better address the schedule impacts from problems identified in OT?

Efforts to dramatically shorten cycle times appear to be episodic and short-lived. Despite periodic calls for dramatically reduced cycle times (such as a 50 percent reduction), various rapid development processes employed during times of conflict are seen as exceptions and fall into disuse when the conflict ends.

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Summary of Cycle Time Issues

- Cycle times *are seen* as too long and *are* getting longer
  - Is the future years defense program (FYDP)-"packed" with development programs that cannot be executed on the promised schedules with the allocated funding?
- Planning for and overseeing acquisition schedules has been given relatively low priority and focus
- Extremely challenging and changing requirements lead to "beyond-state-of-the-art" technological approaches that are not adequately developed within a planned program schedule and allocated funding
- The "front-end" of the development process, while crucial for setting achievable acquisition cycle times, often results in poorly defined programs with optimistic schedules and cost estimates
- Established processes and review mechanisms for disciplining schedule often appear to be ineffective or ignored
- Little progress has been made in shortening cycle times

Framing Perspective

The approach taken in this front-end analysis was to look broadly across the entire domain of defense program development and acquisition to identify key factors, trends, and contributors to program cycle times with an emphasis on factors that can be addressed by management practices. At the outset it is important to emphasize that the goal of program development and acquisition is getting needed new capabilities in the form of new or improved weapon systems to military users. These are the requirements that drive the development and acquisition process. Related to the development and acquisition of such capabilities are considerations of when such capabilities are needed and the degree to which such capabilities are worth their likely cost. It is well recognized that these three elements—performance, schedule, and cost—are closely interrelated and should be managed in a coherent manner that understands and evaluates these relationships. Another aspect of defense system development and acquisition is that many of these systems are large and complex. Military systems are technically demanding compared to most other types of products, such as consumer products, and often are projected to be in use for decades. This scale, complexity, and length of use makes the assessment of defense systems development and acquisition extremely demanding and creates risks in achieving the desired performance, identifying costs in advance, and determining and executing realistic schedules. Simply put, as DOD seeks demanding capabilities relative to identified or projected threats, or to take advantage of emerging complex advanced technologies, the job of projecting when the capability can be developed and acquired, as well as what it will cost will be more difficult than for many commercial systems. The focus of this research is on ways to improve DOD's acquisition management process.

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Framing Perspective

Objective: Produce an exploratory assessment that is

- Encompassing—spans the problem
- Illuminating—contributes to understanding
- Practical—focuses on management concerns

This is the "front-end of the front-end" —

Review and synthesize literature and assessments of defense acquisition, other government processes, and commercial industry with emphasis on identifying factors that contribute to systems development times and processes for [1] managing and [2] [possibly] reducing cycle times.

- Reviewed over 60 documents—articles, research studies, dissertations, theses, government documents, etc.
- Reviewed recent data analyses conducted by OSD
- Interviewed former government officials, industry execs
- Held internal roundtables with IDA subject matter experts (SME)

Three Different Management Problems

IDA has identified three different management problems related to acquisition cycle time:

1. Setting realistic schedules: The first problem is effectively assessing what a reasonable schedule for a program should be relative to the chosen performance capabilities. The fundamental question is when is the capability needed? How time constrained is the need relative to the level of capabilities needed? For a projected schedule to be useful, the project itself must be well-formed, based on sound engineering and the schedule derived from the work needed to achieve the intended result. Analyses have shown that DOD programs have generally been overly optimistic about determining how long it will take to achieve the stated capabilities and a realistic assessment of technology readiness. Moreover, there appears to be limited analytical focus on assessing the time it will take to achieve one level of capabilities relative to another level and trading off the level of capabilities in favor of earlier delivery. Another factor in setting realistic schedules is identifying and providing for uncertainties and risks in achieving the desired outcomes. Do programs fund parallel risk reduction efforts, such as the development of alternative designs for key components, with the expectation that this will reduce the potential for delays? This problem of realistic and well-determined initial schedules is a fundamental question for defense management.
2. Reducing schedule growth: Once a schedule is set, data show that programs often do not adhere to the schedule—the programs usually do not meet intermediate milestone dates and usually deliver late. IDA beleves that this stems largely from the first problem: overly optimistic initial schedules cannot be met and thus they will likely "creep" longer. However, even with well-formulated initial schedules, incentives and exigencies tend to push time to results longer than planned, especially if no contingencies are provided for uncertainty. Thus, identifying incentives that foster schedule growth and addressing how these can be mitigated should be a useful focus.
3. Reducing cycle times: Data show that major defense systems development and acquisition tend to take many years—on the average of seven to ten years. Some have argued that this is too long—often using commercial industry as a basis for comparison. It is important to note that DOD systems stress several domains such as performance, operational deployment environment, and length of system use, that are extreme compared to most commercial systems. Moreover, it is not clear that commercial systems that have similarly stressing characteristics are developed and delivered in substantially less time.

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Three Different Management Problems

1) **Setting realistic schedules**
   - Explicit analysis in the schedule/performance requirements trade-space leading to a decision ***before*** the schedule is set and codified in an approved program plan
   - Establishment of executable schedules for a range of potential program performance goals

2) **Reducing schedule growth**
   - Enforcement of realistic schedules
   - Stable funding (with adequate reserves?)
   - Authority to trade performance goals for schedule—Who? Program Manager (PM)?

3) **Substantially reducing cycle times**
   - Developing and implementing new acquisition strategies and attendant processes for more iterative, adaptive development and acquisition

Proper upfront design of the weapon system and the program are crucial to getting schedules right

Focus Areas for Understanding Cycle Time

IDA's review has identified the following questions as key for assessing program cycle time from a management perspective:

1. Priority and Focus—How important is cycle time in the decision process and how do the current processes for setting and assessing schedules reflect the management interest?
2. Requirements Definition—How are program requirements set and how do these impact program schedules? A related question is what type of information is available and considered during requirements formulation that impact on setting the initial schedules? There is also the underlying question of when realistic program schedules can be set relative to the degree of program definition? One hypothesis is that program schedule dates, such as initial operational capability (IOC) are set too early in the program definition process, become "hardwired" into the program (particularly if reported to Congress), and these become unrealistic as the program is subsequently pursued.
3. Management and Oversight—How are schedules set, assessed and evaluated relative to overall management of the program?
4. Program Definition and Characteristics—Does the type of program (e.g., aviation, missile, IT, etc.) affect how long a program takes and how well a program schedule can be predicted and maintained?

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Potential Cycle Time Influence Vectors

- **Priority and focus**
  - How important are schedules? How are acquisition schedules actually set and how are they changed? What are these changes based on?
- **Requirements definition**
  - How does the development and specification of requirements and the requirements process affect program schedules?
- **Management and oversight**
  - How does program management incentivize and manage schedules? How do oversight processes address schedules?
- **Program definition and characteristics**
  - Which types of systems or programs demonstrate which different problems? Do different types of systems show different outcomes? Why?

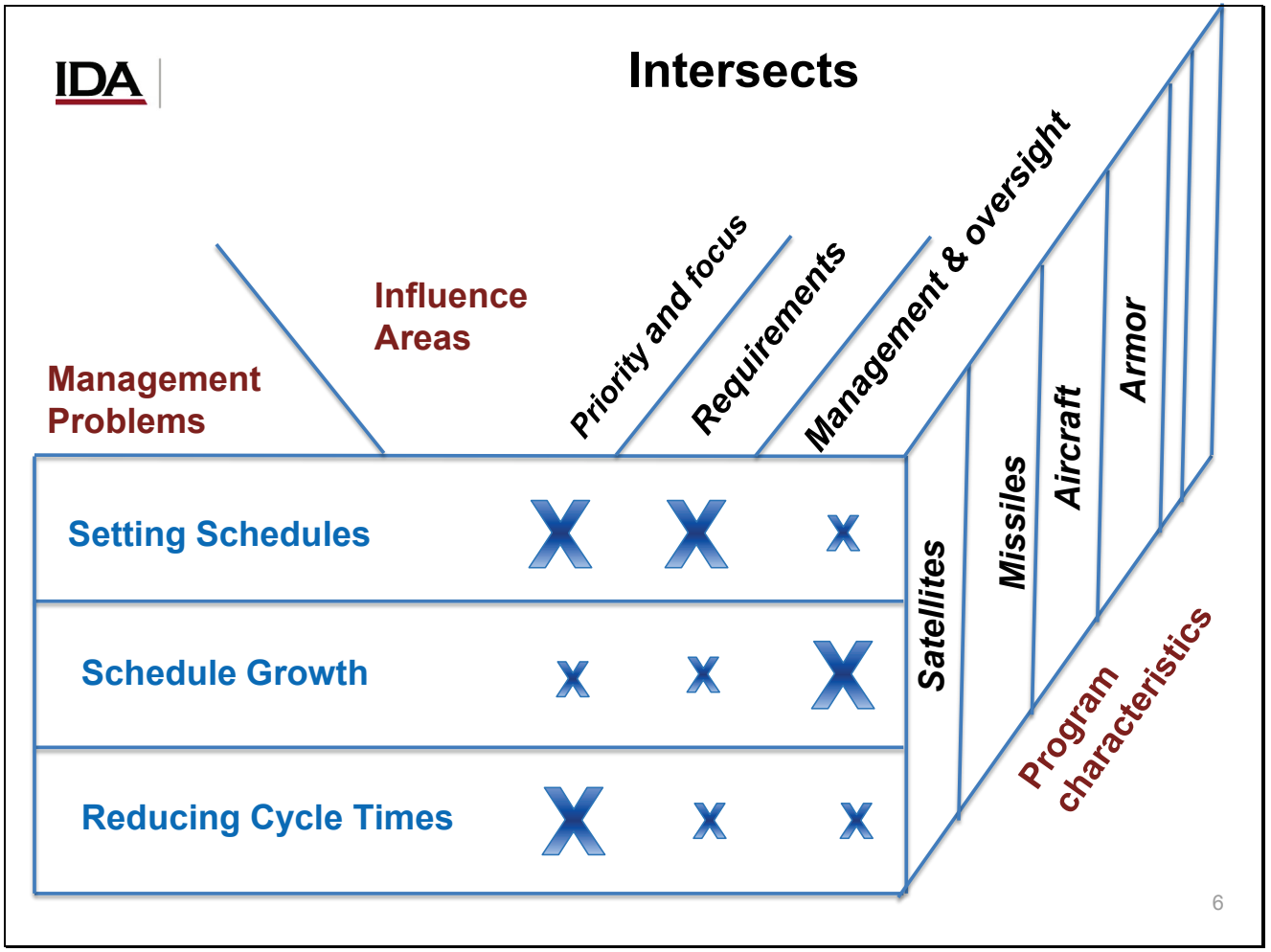
Intersects

This diagram portrays how the assessment areas relate to the key management problems.

As will be elaborated upon later, some of these assessment areas seem of greater importance to particular management problems, but this is also something that will be better understood as research proceeds. The large Xs in the slide denote the areas hypothesized to be of greatest relevance for future research focused on that management problem—for example in "setting schedules," "priority" and "requirements" are likely to be of greatest relevance, while "management and oversight" is less of a factor (denoted by a smaller x). Alternatively, for "schedule growth" our hypothesis is that "management and oversight" will be the dominant factor.

"Program characteristics" are depicted as an additional dimension, as the impact of different types of systems or program characteristics on setting schedules and managing them is seen as variable and largely undetermined—that is, certain types of systems may pose much larger or different challenges than other types. However, it is not yet clear from available empirical analyses which programs have which effects. Thus, while program characteristics may be an important factor in reducing cycle times, specifically which types of programs would have such effects is an open empirical question.

Subsequent slides will detail IDA's initial findings, mostly derived from the detailed literature review, on each of these research areas and then recommend additional research to better understand the area.


IDA
Intersects
Influence Areas
Management Problems
Priority and focus
Requirements
Management & oversight
Satellites
Missiles
Aircraft
Armor
Program characteristics
Setting Schedules
Schedule Growth
Reducing Cycle Times
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Initial Findings: Priority and Focus

A review of previous research indicates that schedules for defense development and acquisition programs are given relatively little focus, in relationship to other concerns—especially the performance of the system and its cost. Interviews with program managers in a study conducted sixteen years ago (McNutt, 1998) found that schedules were generally set using, at best, high-level milestones and timelines, and were not based on detailed work breakdown analysis that specifically considered risks of achieving technical objectives. The McNutt study made an important observation: the schedules set early in the program development process, although rather cursorily derived, become the basis for schedules in subsequent requests for proposals (RFP) and then the bids by contractors. Moreover, if schedules are given this rather cavalier treatment, it raises questions of how trade-offs are made regarding what capabilities to get to the field by when. Since this information is from several years ago, it may be useful to follow up on this topic to determine whether practices have changed.

Initial Findings: Priority and Focus

- IDA's review of prior studies *strongly indicates* that cycle time is given relatively little priority and defined rather arbitrarily in project planning, management, and review. Are there "levers" that can change this?
  - Establishing an analytical basis for initial operational capability (IOC)?
  - Should setting the IOC wait until an executable (funded) program plan has been defined?
- IDA identified a specific Air Force effort that was aimed explicitly at managing cycle time—What were its results? What happened to it?

Lack of focus and rigor in setting program schedules has consequences:

- Processes don't adequately address the value of getting capabilities into the field relative to costs and performance
- Unrealistic schedules become embedded into the requests for proposals (RFP) and contracts with subsequent costs and delivery problems

Future Research Area 1: Priorities

Many questions can be raised when looking at how program baseline schedules are determined for establishing and managing programs, and what tools and data program offices use to create schedules.

What is in requirements documents regarding when a capability is needed? How are these translated into program schedules? How are these schedules reviewed and evaluated relative to risks, reasonableness, and trade-offs? When programs are modified, how are time "needs" considered?

How do analysis of alternatives (AOA) treat schedule? (Corollary: How are AOAs treated?)

What are the practices for training program management staff in schedule setting? Are risk analysis/risk management techniques applied to setting/assessing schedules? Are these used? By whom? How does schedule fit into the systems engineering process and what is the schedule based upon?

What is presented to defense acquisition boards (DAB) regarding schedule and schedule risk?—one interesting example might be the Independent Schedule Assessment input to the F-22 aircraft DAB.

How are schedules set and modified in the contracting process? In the RFP, how are schedules presented and what are the rationales underlying them? How are they treated in the source selection criteria and process? How are schedule incentives provided in contracts? How are these evaluated?

Another line of inquiry is to explore how some defense program organizations have effectively determined and managed program schedules. Are there lessons to be learned and practices to be emulated? For example, to what extent are program schedules considered in the annual program budget decision process within the Components and OSD?

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Future Research Area 1: Priorities

- How are schedules set? Based on what input information, approaches, tools, decision processes?
  - Review and follow-up on Air Force study (McNutt, 1998) and subsequent Air Force implementation efforts
  - Access and review scheduling inputs for selected MDAPs
  - Identify and review how schedule development is treated in program management training and management tools
  - Interview selected SMEs (e.g., former PEOs/PMs)
- Identify and assess examples where schedule-based projects have been effectively designed and managed.
  - Review literature and program documentation—RAND, NAVAIR (F18 E/F, E-2D)
  - Seek to identify what management levers are used by "schedule disciplined" programs (e.g., are there explicit contract mechanisms used in the R&D contracts to spur/incentivize meeting schedules? How are these drafted and overseen?)

Initial Findings: Requirements

In assessing defense acquisition performance, multiple studies have identified that requirements for demanding capabilities are a major factor in why major defense programs take a long time to achieve their results. While, perhaps this is easy to understand, it is not a sufficient explanation for defense acquisition schedules for several reasons: (1) demanding capabilities have been achieved in relatively short times—as exemplified by the F-117A aircraft which met an IOC of four years (with a prior HAVE BLUE prototype); (2) estimating in the face of demanding capabilities requires understanding and evaluating the technical status of the technologies needed for the proposed capabilities relative to when they can reasonably be developed, assessed, and integrated into a defense system and it is unclear whether these assessments are made when schedules are set; (3) demanding capabilities may be achieved in various manners, such as through incremental or spiral approaches or through separate technology development efforts parallel to systems development, that do not necessarily involve long systems cycle times to deliver some level of capabilities to the field—recognizing that such approaches require sound cost-effectiveness assessment.

Highly demanding performance becomes "excessive" performance if requirements are set without due attention to and consideration of what is known about current and projected technical capabilities and the uncertainties in achieving the stated required level relative to what is known about potential adversary capabilities. Projecting capability requirements and the rate of technology development is fraught with uncertainty, and the farther into the future the projection, the greater the uncertainty. A manager seeking to control cycle time might usefully examine how projected schedules from the requirements process are treated and incorporated into the systems development and acquisition process. How are user requirements translated into project development? What do they drive and how do they affect schedules? Does the requirements process contribute to efforts to implement unproven technologies? What can alleviate this? Do requirements processes (AOAs) adequately assess or trade off performance against time?

Requirements instability has been shown to impact cost and schedule growth in defense acquisition. However, there are several potential reasons for requirements to change, including a changed view of the national security threat or a better definition of what is needed to meet a particular threat. Another possibility is that changes are made to provide additional or different ("improved") capabilities that are not directly justified by requirements, but pursued through an agreement at the program management and contractor level. Empirical questions are (1) How much have requirements changed during program development? (2) What were these based on? (3) How did they affect schedules? (4) To what extent do performance "enhancements" become major contributors to schedule growth and how do these get approved in the program management process?

Initial Findings: Requirements

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There are two "requirements" problems: excessive requirements relative to the state-of-the-art and changing needs during execution

- Requirements processes lead to "excessive" performance/ technical requirements driving excessive times to IOC
  - Linkage between user requirements and project schedules is not well documented—what do they drive and how do they affect schedules?
    - Does the requirements process contribute to implementing unproven technologies too quickly? What can alleviate this? ICE?
    - Do AOAs adequately assess or trade off performance against time?
- Requirements "instability" has been shown to impact cost and schedule growth in defense acquisition—what are its causes, and how have some programs been able to suppress it?
  - Do requirements processes allow for or accommodate spiral or incremental approaches to provide "needed" capabilities? To what extent have such approaches been successfully implemented?
  - "Lower-level" performance demands inserted into the development process appear to stretch schedules. How do these get inserted and how are they assessed relative to their impacts on schedules?

Future Research Area 2: Requirements

A basic consideration is what does the user community convey to the development community concerning when the capabilities it wants are needed? How explicit are the statements of when the capabilities are needed? How are they derived and what are they based on? How much flexibility is there in projected times and what are the risks entailed in not meeting them?

A second question is how are these required times-to-product reflected in the development and acquisition program, both at the program's formulation and in its execution? When it becomes apparent that the program will not be able to deliver the specified capabilities at the scheduled delivery milestone, how is the user involved in determining how to proceed? How is the effect of stretching the scheduled delivery of the capability evaluated?

From an empirical basis, what can be discerned from program initiation documents and subsequent program changes on how schedule is considered in the execution process? When program schedules are changed how are these reflected in deliberations with the user community?

Schedule has been proposed as a key performance parameter (KPP) for Major Defense Acquisition Programs (MDAP). Has this been reflected in processes to set these schedules and assess progress based on them? What is or should be the basis of a schedule KPP?

With regard to requirements instability—what kind of requirements are changed and how do these changes affect schedule? Where in the process are these changes allowed and who oversees or controls their execution? Are such changes frequently done "informally" and thus not transparent? If the scope of the work based on such changes increases over the program's execution, does this impact stretch out schedules? How is this reflected in management concerns about time to product?

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Future Research Area 2: Requirements

- How are “user requirements” translated into program development and management?
  - How do inputs from the requirements process affect the product development schedule?
  - To what extent do users establish the intended IOC requirement that becomes part of the initial program plan as reported in the Summary Acquisition Reports (SAR)?
  - How are the impacts of schedule changes assessed relative to the impact on requirements?
  - How are changes in capabilities during development assessed relative to schedule impacts?
- How are the operational impacts of schedule delay assessed?
  - What analytical tools or approaches are available to assess such impacts and are they used? By whom? Do such assessments impact decisions?
  - How is program delay communicated from the program to the user community and what role does the user community have in schedule delay decisions?

Initial Findings: Management and Oversight

Defense development and acquisition programs are complex, highly technical endeavors contracted to industrial systems integrators managed through Military Service program offices. Program offices exist to provide capabilities to a separate user community, but work within a changeable financial environment that affects their efforts. Managing such programs effectively requires a highly skilled and trained program management staff having the tools and the necessary time to formulate, contract, oversee, assess, and provide proper guidance for their programs. Various publications and review groups have raised concerns about the quality and sufficiency of these staffs as well as the analytical tools they employ. Another concern raised is the lack of incentives for these staffs to address schedules and to raise concerns about progress on achieving results within specified times. Reportedly there is a tendency for program offices to try to work with the contractors to adjust or fix issues of performance, which often entails stretching out schedules. Yet, there are examples of programs that have delivered complex capabilities on schedule and within cost. Are there lessons to be learned from these programs?

A second area of concern is the role of "oversight" relative to program management. There are different forms of oversight at different times in a program starting with its inception. Oversight involves several different organizations and responsibilities at different levels from the program office to the service acquisition organizations and the "corporate" oversight provided by the Office of Secretary of Defense. While some have claimed that oversight is itself a factor in causing schedules to grow (both for programs taken together over time and within individual programs) others have responded that the oversight process (especially test and evaluation) identifies problems that should have been addressed earlier, and that the subsequent stretch of schedules is due to earlier problems that the management and oversight process did not identify or address. What recent OT&E review (as well as prior research by IDA) shows is that testing reveals problems that need to be fixed if the program is to meet its performance parameters, but these usually require additional development work that increases both the system's schedule and cost. What is not well documented is why such problems are not identified or addressed before IOT&E. IDA and others have assessed "bad actors" (that is, extreme cases relative to cost and schedule growth) and attributed much of the problem to poor or inadequate focus upfront on both the program and system design—which, ironically, would require greater time and resources in the pre-Engineering and Manufacturing Development phase. There is ample evidence that inadequate attention to such analyses and engineering upfront subsequently results in major program difficulties.

IDA | Initial Findings: Management and Oversight

- Prior studies indicate that oversight in itself is not a major factor in cycle time (contrary to “conventional wisdom”) Oversight has not prevented major excesses, such as F-22, Ground Mobile Radio (GMR), Future Combat Systems (FCS), etc.
  - Is it [1] provided at the wrong time on the wrong things with too little information too late in the process? [2] ignored or overwhelmed by other factors?
- Management incentives, processes, and capabilities are seen as inadequate to deal with issues of cycle time. Is the oversight process not adequately identifying problems to be managed?
  - Incentives for addressing problems appear to put schedule last
  - Incentives for raising issues are weak
  - Incentives, in general, are not aligned with identifying and raising problems (Who loses if a program is late?)

Future Research Area 3: Management and Oversight

There has been relatively little research on how program management applies to effectively assessing and overseeing schedules of defense programs. Air Force research (Wirthlin; Air Force Institute of Technology (AFIT); McNutt) explored the systems development and acquisition process focusing on what drives unfavorable outcomes in terms of cost and time. Some factors stand out: the process' sheer complexity, the number of parties involved with different motivations and agendas, the problem of time to document and communicate findings and positions in dispersed operations. More elusive is understanding how some programs fare relatively well in this process while others become notable for excessively long times to fielding relative to planned schedules. One possibility is that aberrant programs are in fact those that do not follow the strictures of the management processes and are pushed through despite signs of incipient problems—or the signs are not identified until decisions have been made that are difficult to reverse. An area for further exploration would be to review how and why decisions are made that do not properly assess or consider the risks of unfavorable outcomes and how other programs have mechanisms that adequately address such factors. Are there processes and approaches that can prevent poor outcomes, or are these largely due to individual decisions to proceed despite either not having the information or not properly considering it?

What management factors are involved in poor outcomes? With appropriate management capabilities (including requisite skills, tools, and information) exercised could many problems be averted? Alternatively, are extreme schedule and cost growth more often due to external exigencies—such as budget cuts, high-level changes in priorities, or changes in national security requirements? If so, internal management would be less culpable or able to address program schedule and cost impacts. One useful exercise might be to assess extreme outcomes relative to whether the outcomes were primarily due to the unforeseen and uncontrollable external factors or due to poorly defined, evaluated, and overseen programs where problems were ignored or ineffectively identified or addressed.

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Future Research Area 3: Management and Oversight

- What do acquisition process assessments show as factors leading to long cycle times and what can discipline these?
  - Review AFIT process model findings to identify potential control factors
  - Review and assess various study findings indicating that oversight is not major contributing factor (IDA, OT&E, McNutt)
- What role do underlying resource factors, such as training, skills, tools, insufficient personnel relative to tasks, budget reductions during program execution, play in setting and managing program schedules—how are these allocated relative to other demands?
  - Review prior studies (Defense Science Board (DSB), GAO, others?)
  - Interview IDA SMEs (former PMs, etc.)
  - External interviews with PMs and acquisition executives

Initial Findings: Program Characteristics

Prior research has shown that there are evident differences in schedule length and schedule growth for different types of programs at different times. Analyses have shown that certain types of weapon systems, such as combat aircraft and satellites, take longer to develop and acquire than other systems. Moreover, some types of systems within a weapon category have been shown to take longer than others. This research has traced some of these results to underlying factors, such as complexity or the introduction of new types of technologies (such as digital electronics in earlier missile systems). What is apparent from these analyses is that not all acquisition programs perform badly—indeed some achieve their intended results close to the initially projected times and costs. While on the average schedules have grown some, this growth (looking at medians) may not be a major concern, given the additional complexities of current systems compared to those of the past. However, it is also the case that throughout defense acquisition there have been major programs that have taken much longer than others. It appears that these aberrations are increasing both in quantity and in terms of development and production timelines. Can the underlying factors of these extremes be isolated relative to other programs and are there potential means to identify such prospects early-on and intercede to avoid such outcomes?

Initial Findings: Program Characteristics

Different types of systems have shown different schedule behavior over time

- What factors contribute to the differences? What do these imply about understanding schedules?
- How to measure technological maturity and system complexity and their schedule effects? Have any programs been specifically managed with these concerns? How and to what effect?
- What characteristics differentiate “bad actors” from others? Are there management tools for identifying these prospects upfront and avoiding them? Are there potential I&W factors for cycle time?
- What types of program characteristics are related to (drive) schedule problems, e.g., concurrency, jointness?

Future Research Area 4: Program Definitions and Characteristics

One area for focus is to look at how "bad actors" have affected acquisition system aggregate schedule and cycle time results. Large differences between the median cycle time (such as time to IOC) compared to the mean would illuminate the effect of the outliers on the acquisition system's aggregate performance. This could be assessed for different types of systems as well as different time periods.

Another avenue of research is to determine the correlation of Technology Readiness Level (TRL) data with cycle time/schedule data. Do low TRLs correspond with high/missed schedules? Are appropriate data available for making such an assessment?

Selected Acquisition Report (SAR) data augmented by data from the requirements process could be used to assess the evolution of the planned and actual schedule over time. Parallel data for the KPPs that are included in the SAR could be compared to these dates to see if there is a relationship between schedule and performance. Data from Defense Acquisition Management Information Retrieval (DAMIR) shows the evolution of procurement plans drawn from the SARs. Together, these data might support analyses of how procurement of the systems was affected by any schedule stretch in development.

Another assessment could use historical future years defense plan/defense program projection (FYDP/DPP) data to give planned/actual force structures which would show when equipment is fielded as well as how equipment would be retired as new equipment comes into inventory. Changes in these data might show how delayed procurements affected the need to maintain and support older systems.

Another focus could be to identify measures of the consequences of being late relative to other impacts—such as costs to upgrade and keep legacy systems in the field. One clear factor is the cost growth of the systems themselves and the impact of the reduced number of systems fielded. What is the relationship between program stretch and the probability of a program being cancelled and the attendant impacts of funds and effort wasted as well as unsatisfied requirements? Can outcome measures be derived relative to force structure impacts?

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Future Research Area 4: Program Definition & Characteristics

- Which types of systems or programs demonstrate cycle time problems?
  - Do different types of systems show different outcomes? Why?
  - Differentiate “drivers” of schedule growth for development programs: type of system, complexity, technical maturity, etc., and assess available data on their impacts at different time periods.
- What are the implications of the distribution of current systems developments regarding such characteristics (type of systems and drivers of schedules)?
  - What analytical tools or approaches are available to assess their impacts?
  - Can these be used to direct management approaches focused on averting potential problems?

Initial Findings: Reducing Cycle Time

A recent call for reduced cycle times was made in the Office of Secretary of Defense's Better Buying Power (BBP) 2.0, which states that its objective is to "reduce cycle times while ensuring sound investment decisions: This initiative will assess the root causes for long product cycle times, particularly long development cycles, with the goal of significantly reducing the amount of time, and therefore cost, it takes to bring a product from concept to fielding" (Kendall 2012).

Embedded in this objective are underlying concerns about the effectiveness of the DOD acquisition system to deliver needed capabilities in a timely manner. These concerns reflect a number of prior admonitions from a range of organizations, study boards, and reviews that the DOD acquisition system is too slow in meeting defense needs. Periodically there have been calls for DOD to fundamentally alter its approach to acquiring major weapon systems with the objective of reducing time-to-product. Some earlier assessments have called for reducing cycle times by as much as 50 percent. The BBP 2.0 statement links time to cost—indicating that taking longer to develop military capabilities adds to their costs.

The DOD has developed and built extraordinarily complex systems that often are at the state of the art of technological knowhow. These weapon systems and even more complex "systems of systems" are designed, developed, and acquired to provide capabilities to assure the security of the United States against a broad range of current and future threats. The United States military posture stresses that its military capabilities must provide technological superiority relative to its potential adversaries. Because of these demands, DOD weapon systems are costly and considerable time is needed to develop and produce systems of their scale, scope, and complexity. However, the concern is that these trends have reached a point where the cost and time are becoming too great relative to getting the needed capabilities into the field. In a world of globalized technology where potential adversaries and competitors are more rapidly accessing and developing advanced technological capabilities, time-to-product may be much more important than in the past. Can defense acquisition cycle times be substantially reduced and still achieve needed defense capabilities?

It is important to emphasize, however, that reducing cycle times in any substantial way raises fundamental questions about Defense Acquisition Strategy (what is to be bought in what way) that are beyond acquisition management and oversight. It is likely that to truly reduce acquisition cycle times on the order of 50 percent would entail a revamped acquisition approach using a strategy of strict adherence to proven technologies in a spiral development process. Indeed, this is precisely the approach taken by leading high technology systems firms. While such approaches have been advocated by some for DOD, they also are not currently embedded in the DOD systems development and acquisition process (or represented by DODI 5000.02).

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Initial Findings: Reducing Cycle Time

- The Office of Secretary of Defense's Better Buying Power 2.0, states that its objective is to:

  Reduce cycle times while ensuring sound investment decisions: This initiative will assess the root causes for long product cycle times, particularly long development cycles, with the goal of significantly reducing the amount of time, and therefore cost, it takes to bring a product from concept to fielding.

- Studies refer to commercial cycle time as an objective for DOD—citing "time-to-product" as key business driver
- Defense systems may have characteristics (complexity, use in extreme environments, etc.) that prevent strict use of commercial practices, but some lessons may transfer
- Competitors and adversaries are more quickly adopting advanced capabilities, raising concerns about U.S. technological superiority

Reducing cycle times raises fundamental questions regarding Defense Acquisition Strategy (what is to be bought in what way) that are beyond management and oversight

Future Research Area 5: Approaches to Reduce Cycle Time

From the perspective of identifying further analyses to achieve better managed programs, one focus might be on developing ways to institute effective scheduling as a management practice within the Department of Defense.

To what extent and to what effect have there been specific attempts to manage or reduce defense program schedules? What has been attempted and what have been the results?

How do different acquisition strategy or approaches (for example, spiral acquisition and agile development) address schedules; have these been employed in defense and with what results?

This raises two different management questions: (1) how to manage and discipline schedules under the *current* acquisition process and (2) how to reduce acquisition cycle time using fundamentally different acquisition processes. This distinction is important because it sets some boundaries on what is achievable relative to time, cost, and probability of success. What strategies are likely to succeed? Have any such attempts been made and have they succeeded (Younossi, et al., 2005)?

Finally, reducing acquisition cycle time should be assessed and related to broader management objectives. It is generally accepted, and recent studies verify, that program cycle times should be less if the program is based on less advanced and, thus, better known technologies and processes. A crucial element of determining schedules is what is trying to be achieved—and this directly relates to requirements and the technology development process. Given the uncertainties, both in the requirements and the funding processes, shouldn't the focus be on greater agility and flexibility in the acquisition system? Such agile, flexible, adaptable approaches have explicit implications for setting schedules and changing them. Can such processes be implemented effectively in the DOD (Patel and Fischerkeller 2013)?

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Future Research Area 5: Approaches to Reduce Cycle Time

Priority and focus: **What explicit attempts have been made to manage and/or reduce cycle times with what results?**

Requirements definition: **How do warfighter needs from field (e.g., joint urgent operations needs (JUON) affect program schedules?**

Management and oversight: **Are there management tools and approaches that can be used to dramatically reduce cycle times? When should these be used?**

Program definition and characteristics: **Which types of systems or programs can be managed to significantly reduce cycle times? What are their characteristics?**

Some Broader Concerns

The purpose of this initial research and the future program of research proposed in this paper is to provide a basis for better understanding defense acquisition program cycle times—the time it takes to get from initial concept definition, through development and production into an operating capability. This research program is motivated by a long-standing concern in the DOD that acquisition program cycle times are too long and getting longer, but is focused on more specific questions:

Data show that cycle time distributions (similar to cost) are highly skewed with several aberrations of extremely long cycle times as large outliers from the norm. From a management perspective should identifying and reducing such outliers be the most important aspect of cycle time management? Should the understanding of weapon system cycle time be focused on the extremes of the distribution? What are the implications of such extremes relative to "normal" acquisitions?

Is the notion of "should time" (analogous to "should cost") appropriate? If so, how should it be derived? Is the idea that cycle time either in general or on average should be reduced by some factor (e.g., 50 percent or 25 percent) based on a sound rationale? Does it over simplify the problem by ignoring the interplay between time, cost, and performance? Does it appropriately consider the complex nature of defense systems? Data show that the "norm" (i.e., median) cycle time for systems has generally increased over time. Should this, in itself, be a significant management concern?

How important is the content of the cycle rather than the overall time? Are certain elements taking longer; if so, why? Should some take longer to improve overall results?

Generally, schedule estimates have been overly optimistic, with actual times longer than those estimated. Should estimates of cycle time be developed differently? Are these estimates a management concern?

How should cycle time be assessed relative to program failures, where programs were cancelled either because their cycle times were so out of control or the threat for which they were designed was judged to have changed? Is there a relationship between schedule problems and prospects of program failure?

Is cycle time an indicator of the need for a different way to acquire defense capabilities? If the cycle times in the current approach are seen as too long and getting longer, does this indicate the need to develop and acquire capabilities differently?

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Some Broader Concerns

- Is the notion of “should time” appropriate? If so, how should it be derived?
- From a management perspective, should identifying and reducing extreme outliers be the most important aspect of cycle time?
- How important is the content of the cycle phases rather than the overall time?
- Is there a relationship between cycle time problems and prospects of program failure?
- Does a longer cycle time indicate the need for a different way to acquire defense capabilities?

Preliminary Work Plan

Periodically, defense weapon system acquisition cycle time (i.e., the time it takes to get a weapon system program through development into production and fielding) has been flagged as a concern. While there is some evidence that cycle time has gotten longer in recent decades, there is no clear evidence that it is, in itself, a major problem or is "getting worse," since it could be more a result of the increased complexity of the systems rather than degraded organizational performance. It is also not clear how much the general (average) increase in cycle time affects operational capabilities.[2] There is, however, evidence of a problem with how schedules are derived and how they are addressed in the DOD development and acquisition process. These problems include:

- Many systems coming in later than projected, raising questions regarding how initial schedules are set as well as downstream implications of such underestimation
- Highly skewed variation, with outliers indicating prospects of major problems for certain types of systems or approaches that result in extraordinary or aberrant delays that may have major implications for defense capabilities
- Pursuit of capabilities that are well beyond the current state-of-the-art (and the impact on schedule and cost) relative to less ambitious capabilities that could be delivered sooner (which raises the questions of how trade off of quicker schedules relative to greater capabilities should be done (Francis 2013))

Based on these initial findings, IDA concludes that further research is needed on the areas of assessment presented in this briefing.

[2] While a system being "later" than initially projected most likely does mean that it will be more costly (per unit) and the overall program costs will rise, it is unclear under what circumstances the system earlier would provide more beneficial capabilities. For example, a system might be late because its technical risk was underestimated and its development had to be stretched. The implication is that for the given capability sought ("required") more technology maturation was required which would have taken more time. Thus it would not be the case that the system [as defined] would have gotten to the field sooner, or even cheaper). Perhaps the relevant, but more difficult, question is: When is a system too late relative to stated needs, such that it is no longer useful or effective, and what are the implications of this?

Appendix A
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Appendix B
Abbreviations

ACTD	Advanced Concept Technology Demonstration
AFIT	Air Force Institute of Technology
AoA	Analysis of Alternatives
COCOM	Combatant Command Authority
CSBA	Center for Strategic and Budgetary Assessments
DAB	Defense Acquisition Board
DAMIR	Defense Acquisition Management Information Retrieval
DOD	Department of Defense
DPP	Defense Program Projection
DSB	Defense Science Board
DT	Developmental Testing
FCS	Future Combat System
FPIP	Fixed Price Incentive Payment
FYDP	Future Years Defense Plan
GAO	U.S. Government Accountability Office
GMR	Ground Mobile Radio
I&W	Indication and Warning
IOC	Initial Operational Capability
IOT&E	Initial Operational Test and Evaluation
IPT	Integrated Product Team
JCS	Joint Chiefs of Staff
JROC	Joint Requirements Oversight Council

JUON	Joint Urgent Operational Need
KPP	Key Performance Parameter
MCR	Mission Critical Reporting
MDAP	Major Defense Acquisition Program
NAVAIR	Naval Air Systems Command
OJCS	Office of the Joint Chiefs of Staff
OSD	Office of the Secretary of Defense
OT	Operational Testing
PEO	Program Executive Office
PM	Program Manager
R&D	Research and Development
RDT&E	Research, Development, Test and Evaluation
RFP	Request for Proposal
SAR	Selected Acquisition Report
SME	Subject Matter Expert
T&E	Test and Evaluation
TRL	Technology Readiness Level
USD (AT&L)	Under Secretary of Defense (Acquisition, Technology and Logistics)

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

This research assessed defense acquisition cycle-time and cycle-time growth by formulating questions focused on how to better understand cycle-time, reviewing data analyses, and identifying additional data and assessments regarding cycle time. The research identified three management problems concerning cycle-time: setting realistic schedules, reducing schedule growth, and reducing cycle-times. The five research findings are that (1) while major weapon system acquisition programs are getting longer, there is less evidence of actual problems that increasing cycle-times either cause or indicate; (2) low priority is given to setting initial schedules; (3) pursuit of ambitious technical capabilities within a system that does not provide mechanisms for identifying and reducing technical risk contributes to long cycle-times; (4) developmental shortfalls requiring more work and time than initially planned are not identified and addressed early on; and (5) little progress has been made in shortening cycle-times.

Four research areas were identified and elaborated into a work plan for future research:

- Priority and Focus—how important is cycle-time in decision processes; how do processes for setting schedules reflect management priorities?
- Requirements Definition—how do program requirements impact program schedules?
- Management and Oversight—how are schedules set, assessed, and evaluated?
- Program Definition and Characteristics—how do different types of programs affect program length? How well can program schedules be predicted?

15. SUBJECT TERMS

acquisition, cycle-time, weapons system, requirements, schedule, technology, technical risk, program management

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